Possible Signal of Quark Reconfinement in Accreting X-ray Neutron Stars[1]

Norman K. Glendenning & Fridolin Weber

The transition between the confined and deconfined phases of quarks can have a remarkable effect on the spin properties of millisecond pulsars and on the spin distribution of the population of x-ray neutron stars in low-mass binaries. In the latter class of stars, *the effect has recently been observed* using the Rossi X-ray Timing Explorer, namely, a pronounced clustering of x-ray stars in a narrow band of spins. The observation cannot be uniquely assigned to the phase transition as cause. However, there is another possible signal—not so far observed—in millisecond pulsars that we previuosly discussed [2] which would have the same origin, and whose discovery would tend to confirm the interpretation in terms of a phase transition in the stellar core. The physics of the phenomenon in both cases is robust because it is analogous to "backbending" of the moment of inertia observed in rotating nuclei and predicted in that case by Mottelson and Valatin [3] to occur as a consequence of a phase transition between a spin-aligned and a BCS spin-paired phase that takes place over a few units of spin.

The calculated spin distribution of X-ray neutron stars in case of a phase transition (open histogram) is compared with recent data from the ROSSI satelite [4] (shaded) in Fig. 1. The calculated distribution is normalized to the number of observed objects (18) at the peak. The spike corresponds to the spinout of the quark matter phase and the corresponding growth of the moment of inertia as compressible quark matter is replaced by relatively incompressible nuclear matter causing accretion driven spinup to temorarily stall for a few tens of million years. Otherwise the spike would be absent.

The stellar model and all parameters are those used in our previous work [2], and no adjustment of parameters was made. To the present, only 18 objects have been observed. When data is more copious, it will be worth while to tune parmaters.

[1] N. K. Glendenning and F. Weber, Astrophys. J. Lett. **559** (2001) L119

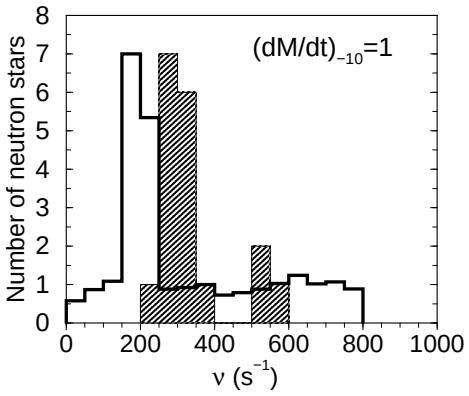

Figure 1: Spin Ditribution of accreting x-ray neutron stars as calculated (open histogram) and observed using the Rossi satellite (shaded histogram) [4].

[2] N. K. Glendenning, S. Pei and F. Weber, Phys. Rev. Lett. **79** (1997) 1603

[3] B. R. Mottelson and J. G. Valatin, Phys. Rev. Lett. **5** (1960) 511

[4] M. van der Klis, Millisecond Oscillations in X-Ray Binaries, to appear in Ann. Rev. Astron. Astrophys, (2000)